

Flora H. Patterson ✓
MARCH, 1908

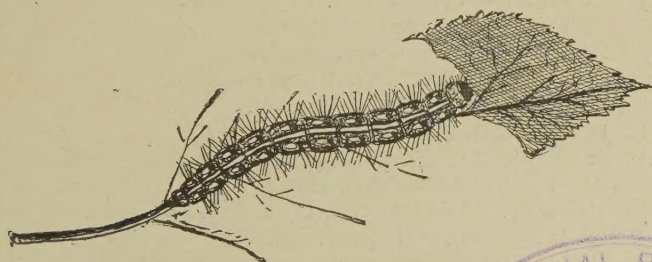
BULLETIN 252

CORNELL UNIVERSITY
AGRICULTURAL EXPERIMENT STATION OF
THE COLLEGE OF AGRICULTURE

Departments of Horticulture, Entomology and Plant Pathology

INSECT PESTS AND PLANT-DISEASES

John Craig.



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The regular bulletins of the Station are sent free to persons residing in New York State who request them.

I. SPRAYING.

JOHN CRAIG.

The "Spray Calendar" originated at the Cornell Agricultural Experiment Station. In 1894, Prof. M. V. Slingerland devised the first tabular calendar arrangement of spraying suggestions; this was printed and used at Farmers' Institutes. In February 1895, this Experiment Station published a "Spray Calendar" prepared by E. G. Lodeman, late instructor in the Department of Horticulture. Since that time, the spray calendar has appeared in many forms and under the authority of many writers and institutions. The Cornell publication has been changed from the chart to the pamphlet form.

Every year there is a distinct demand for the type of information furnished by this calendar. Fruit-growers and farmers realize more clearly when planting season comes that success depends as much upon the application of intelligent methods to the combating of plant parasites as upon the management of the soil.

The Need of Spraying.

The annual loss arising from the incursions of destructive insects in the United States exceed by many times the yearly output of all the gold mines in the United States. The reduction in the value of the apple crop of New York state due to insect injury, cannot be less than thirty per cent per year. This is a heavy tax on the fruit-grower. The injury, however, could be lessened at least fifty per cent by an expenditure of not exceeding two per cent on the value of an average apple crop. The need for spraying is therefore evident. This need will probably increase as time goes on.

The Principles of Spraying.

Plants, unlike animals, are not cured of diseases by medical treatment. Moreover, they cannot be made immune to insect or fungous attacks by previous treatment. We aim by spraying to *protect* plants from two classes of enemies, insects and fungi. We merely protect plants; we do not cure them. How are they protected? By covering the foliage with a medium in which the fungus will not grow, in the case

of the plant parasite; by poisoning the leaf-eating insect, or killing the sucking insect with something which destroys its body, in the case of insects.

Cornell spray calendars have stated that spraying is a type of orchard insurance. Growers ask: Shall I spray when I have little or no fruit? The answer is: Yes, by all means. Insure for your trees a crop of healthy leaves, so that wood may be grown and fruit buds developed. This is the best way to secure a crop the following year. The man who sprays year in and year out insures his crop against standard

enemies, and to a large degree against epidemics, and tends to lessen the numbers of his staple insect foes.

How to Spray.

First, know the enemy. Study the crops you are growing, and you will learn to recognize the parasites that attack them. Learn the feeding habits of these and the principal facts of their life-history. Then study the remedy, understand its principles—how it acts. Next, secure the



Fig. 145. *Slugs of the potato beetle. Chewing insects.*

appliance which seems best adapted to your needs. Prepare your spray mixture carefully, and apply it thoroughly. Next to timeliness, thoroughness is of prime importance. Hundreds of fruit-growers and farmers waste time, energy and material by indiscriminate and hasty squirting of spray mixtures over fruit trees and farm crops. Remember that the principle is protection, and that the plant is protected only when it is completely covered. Some insects must be hit to be killed. Do not spray, therefore, unless you do the work thoroughly for you will disgust yourself and destroy your neighbor's faith in the treatment. Spraying is not pleasant work but fruit-growers and farmers must accept the situation and make the best of it.

In the succeeding pages of this bulletin, the subjects of formulas, machinery, insects and diseases are treated. Each division has been

prepared by an authority in that particular field. Study and follow the directions carefully, apply the remedies in time and with thoroughness, and in case of failure or difficulty write to the Cornell Agricultural Experiment Station for assistance.

II. INSECTS AND THEIR CONTROL.

M. V. SLINGERLAND AND C. R. CROSBY.

For purposes of control, insects are divided into two great classes:

A. *Chewing insects*, or those having jaws by means of which they bite off and eat portions of the tissues of the plant. Examples: Potato beetle, (Fig. 145) canker-worm and codling-moth caterpillar.

B. *Sucking insects*, or those furnished with a beak containing four bristles united into a slender tube. The bristles are inserted into the plant and through them the insects suck out the sap. Examples: Squash stink-bug, San José scale and plant-lice (Fig. 146).

Chewing insects are usually controlled by applying to their food poisons such as Paris green, arsenate of lead or hellebore. *Sucking insects* cannot be reached in this way and must be killed by a direct application of contact



Fig. 146. A plant-louse, one of the sucking insects, showing the beak.

insecticides, such as soaps, oils or other substances. In fighting sucking insects, thorough and skillful work is required since every individual insect must be hit by the spray, while in the case of chewing insects, it is merely necessary to apply the poison thoroughly to the food-plant.

APPLE.

Bud-moth.

The small brown caterpillars with a black head devour the tender leaves and flowers of the opening buds in early spring.

Make two applications of either 1 lb. Paris green or 4 lbs. arsenate of lead in 100 gals. of water; the first when the leaf-tips appear and the second just before the blossoms open. If necessary, spray again after the blossoms fall. For use with Bordeaux, see APPLE SCAB, Cornell Bulletin 107.

These caterpillars are small measuring-worms or loopers that defoliate the trees in May and June. The female moths are wingless and in late fall or early spring crawl up the trunks of the trees to lay their eggs on the branches. Spray thoroughly once or twice, before the blossoms open, with 1 lb. Paris green or 4 lbs. arsenate of lead in 100 gals. of

water. Repeat the application after the blossoms fall. Prevent the ascent of the wingless females by means of sticky bands or wire-screen traps.

This is the pinkish caterpillar which causes a large proportion of wormy apples. The eggs are laid by a small moth on the leaves and skin of the fruit.

Codling-moth.

(Fig. 147.)

Most of the caterpillars enter the apple at the blossom end. When the petals fall the calyx is open (Fig. 148), and this is the time to spray. The calyx soon closes and keeps the poison inside ready for the young caterpillar's first meal (Fig. 149). After the calyx has closed, it is too late to spray effectively. The caterpillars become full grown in July and August, leave the fruit, crawl down on the trunk, and there most of them spin cocoons under the loose bark. In most parts of the country there are two broods annually.

Immediately after the blossoms fall spray with 1 lb. Paris green or 4 lbs. arsenate of lead in 100 gals. of water. Repeat the application 7 to 10 days later. For use with Bordeaux see APPLE SCAB. Use burlap bands on trunks, killing all caterpillars

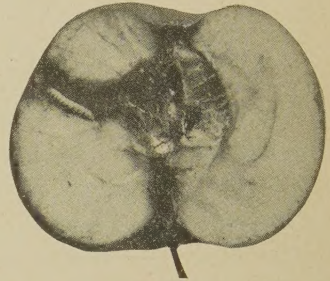


Fig. 147. *Codling-moth caterpillar in the apple.*

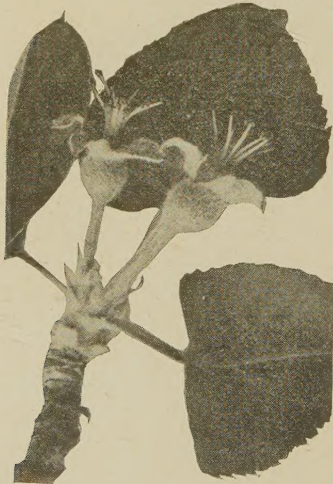


Fig. 148. *Just right to spray. Two apples from which the petals have just fallen. Note that calyx lobes are widely spread.*

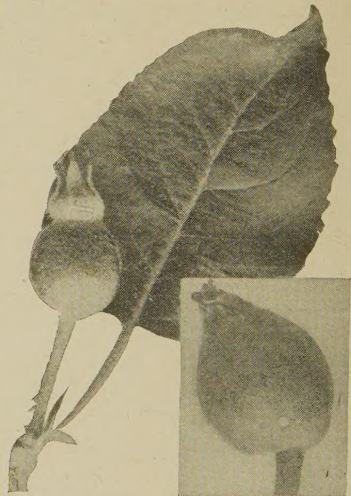


Fig. 149. *Almost too late to spray effectively. Note that the calyx lobes are nearly together.*

Egg of codling-moth on young apple.

under them every ten days from July 1st, to August 1st, and once later before winter. Cornell Bulletin 142.

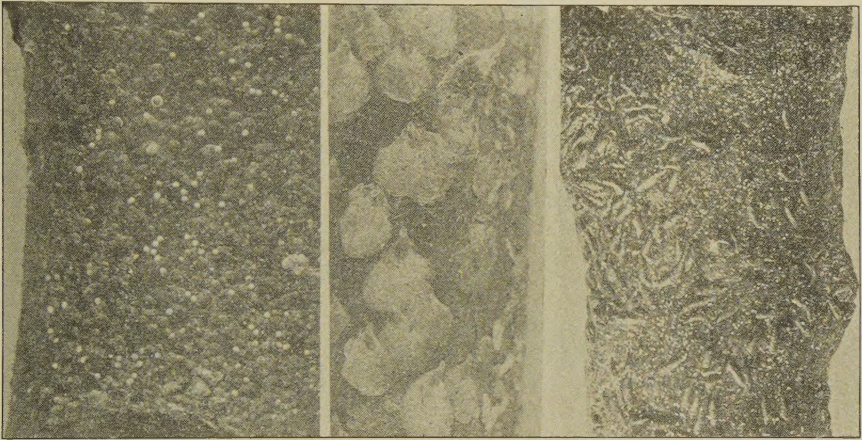
Apple-maggot or "Railroad-worm."

The small white maggots make brownish winding burrows in the flesh of the fruit, particularly in summer and early fall varieties. This insect cannot be reached by a spray as the parent fly inserts her eggs under the skin of the apple. When full-

grown the maggot leaves the fruit, passes into the ground and there transforms inside a tough, leathery case. Cultivation has been found to be of no value as a means of control. The only effective treatment is to pick up all windfalls every two or three days and either to feed them out or to bury them deeply, thus killing the maggots.

The small caterpillars live in pistol—or cigar-shaped cases, about $\frac{1}{4}$ inch long, that they carry around with them. They appear in spring on the opening buds at the same time as the bud-moth and may be controlled by the same means. Cornell Bulletins 93 and 124.

This scale is nearly circular in outline and about the size of a pin head (Fig. 150). When abundant it forms a crust on the branches and causes small red spots on the fruit. It multiplies with marvelous rapidity, there being three or four broods annually and each mother scale may give birth to several hundred young. The young are born alive and



San Jose Scale.

Scurfy Scale

Oyster-shell Scale.

Fig 150. *The three common scales infesting the apple.*

breeding continues until late autumn when all stages are killed by the cold weather except the tiny half-grown, black scales many of which hibernate safely.

Spray thoroughly in the fall after the leaves drop, or early in the spring before growth begins, with lime-sulphur wash, or miscible oil, 1 gal. in 10 gals. of water. When badly infested make two applications, one in the fall and another in the spring. In case of large old trees, 25% crude oil emulsion should be applied just as the buds are swelling. Geneva Bulletins 262, 296 and Circular 9.

Oyster-shell scale.

(Fig. 150.) This is an elongate scale, $\frac{1}{8}$ inch in length, resembling an oyster shell in shape and often encrusting the bark. It hibernates as minute white eggs under the old scales. The eggs hatch during the latter part of May or in June, the date depending on the season. After they hatch, the young may be seen as tiny whitish lice crawling about on the bark. When these young appear spray with kerosene emulsion, diluted with 6 parts of water, or whale-oil or any good soap, 1 lb. in 4 or 5 gals. of water.

Scurfy scale.

(Fig. 150.)

This whitish pear-shaped scale, about $\frac{1}{8}$ inch in length, often encrusts the bark, giving it a scurfy appearance. It hibernates as purplish eggs under the old scales. Spray as recommended for oyster-shell scale.

**Leaf
blister-mite.**

The presence of this minute mite is indicated by small irregular brownish blisters on the leaves. Spray in late fall or early spring with kerosene emulsion, diluted with 5 parts of water, or miscible oil, 1 gal. in 10 gals. of water. Geneva Bulletin 283.

**Round-headed
borer.**

The only practicable method of control is to dig out the borers or to kill them with a wire.

**Apple tent-
caterpillar.**

The insect hibernates in the egg stage. The eggs are glued in ring-like brownish masses (Fig. 151) around the smaller twigs where they may be easily found and destroyed. The caterpillars

appear in early spring, devour the tender leaves, and build unsightly nests on the smaller branches. This pest is usually controlled by the treatment recommended for the codling-moth. Destroy the nests by burning or by wiping out when small.



Fig. 151. Egg-ring of apple tent-caterpillar.

PLUM AND PRUNE.**Plum
curculio.**

The adult is a small snout-beetle (Fig. 152) that inserts its eggs under the skin of the fruit and then makes a characteristic crescent-shaped cut beneath it. The grub feeds within the fruit and causes it to drop. When full grown it enters the ground, changes in late summer to the beetle, which finally goes into hibernation in sheltered places. Spray just after blossoms fall with arsenate of lead, 6 to 8 lbs. in 100 gals. of water, and repeat the application in about a week. After the fruit has set, jar the trees daily over a sheet or curculio-catcher and destroy the beetles. Cornell Bulletin 235.

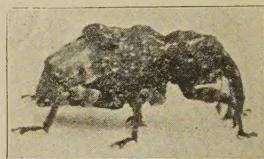


Fig. 152. Beetle of plum curculio. Enlarged.

CHERRY.**Aphis.**

Early in the season these dark brown plant-lice curl the terminal leaves, especially of sweet cherries. Spray with kerosene emulsion diluted with 6 parts of water. Repeat the application if necessary.

Plum curculio. See under PLUM.

QUINCE.**Quince
curculio.**

This curculio is somewhat larger than that infesting the plum and differs in its life-history. The grubs leave the fruits in the fall and enter the ground where they hibernate and transform to adults the next May, June or July, depending on the season.

When the adults appear jar them from the tree onto sheets or curculio-catchers and destroy them. To determine when they appear jar a few trees daily, beginning the latter part of May. Cornell Bulletin 148.

San Jose scale. See under APPLE.

Round-headed apple-tree borer. See under APPLE.

PEACH AND APRICOT.

Peach borer.

The adult is a clear-wing moth. The larva burrows just under the bark near or beneath the surface of the ground; its presence is indicated by a gummy mass at the base of the tree (Fig. 153). Dig out the borers in June and mound up the trees. At the same time, apply gas-tar or coal-tar to the trunk from the roots up to a foot or more above the surface of the ground. Cornell Bulletins 176 and 192.

Plum curculio. See under PLUM.

San Jose Scale. See under APPLE.

PEAR.

Pear psylla.

These minute, yellowish, flat-bodied, sucking insects are often found working in the axils of the leaves and fruit early in the season. They develop into minute, cicada-like jumping-lice. The young psyllas secrete a large quantity of honey-dew in which a peculiar black fungus grows, giving the bark a characteristic sooty appearance. There may be four broods annually and the trees are often seriously injured. After the blossoms fall, spray with kerosene emulsion, diluted with 6 parts of water, or whale-oil soap, 1 lb. in 4 or 5 gals. of water. Repeat the application at intervals of from 3 to 7 days until the insects are under control. Cornell Bulletin 108.

Leaf blister-mite.

See under APPLE. On pears, the lime-sul-

phur wash has also been found effective.

San Jose scale.

See under APPLE.

Codling-moth.

See under APPLE.



Fig. 153. Peach borer.



Fig. 154. Pear slugs skeletonizing the leaf.

Pear slug. These small, slimy, slug-like, dark green larvae (Fig. 154) skeletonize the leaves in June, and a second brood appears in August. Spray thoroughly with 1 lb. Paris green, or 4 lbs. arsenate of lead, in 100 gals. of water.

NURSERY STOCK.

Plant-lice. Spray thoroughly or dip the tips in kerosene emulsion, diluted with 6 parts of water, or whale-oil soap, 1 lb. in 5 gals. of water.

San Jose scale. After the trees are dug, fumigate with hydrocyanic acid gas, using 1 ounce of potassium cyanide for every 100 cubic feet of space. Continue the fumigation from one-half to three quarters of an hour. Do not fumigate the trees when they are wet, since the presence of moisture renders them liable to injury.

GRAPE.

Flea-beetle or "Steely-beetle." The small, shining blue beetles appear in early spring and eat into the opening buds. The

brown larvae feed on the leaves in May and June. When buds begin to swell cover them thoroughly with arsenate of lead, 8 lbs. in 100 gals. of water, or when beetles appear, hand-pick them into a pan containing a little kerosene. To kill the larvae on the leaves from May 15th, to July 1st, add 1 lb. Paris green or 4 lbs. arsenate of lead to every 100 gals. of Bordeaux mixture. See under BLACK-ROT. Cornell Bulletin 157.

Root-worm. The small white grubs.

(Fig. 155) feed upon the roots, often killing the vines in a few years. The adults are small grayish-brown beetles that eat peculiar chain-like holes in the leaves during July and August. Cultivate thoroughly in June especially close around the vines to kill the pupae in the soil. Spray thoroughly the latter part of June with arsenate of lead, 6 lbs. in 100 gals. of water, to kill the beetles. Repeat the application in a week or ten days. Cornell Bulletins 208 and 224, 235.

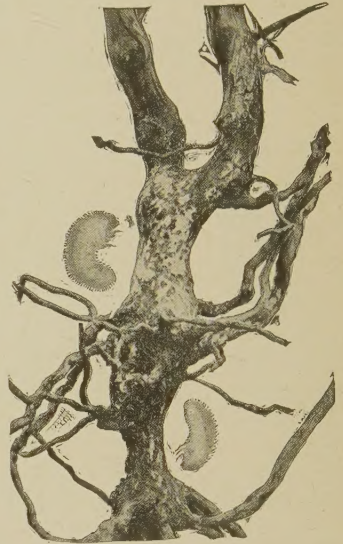


Fig. 155. *Grape root-worm.*

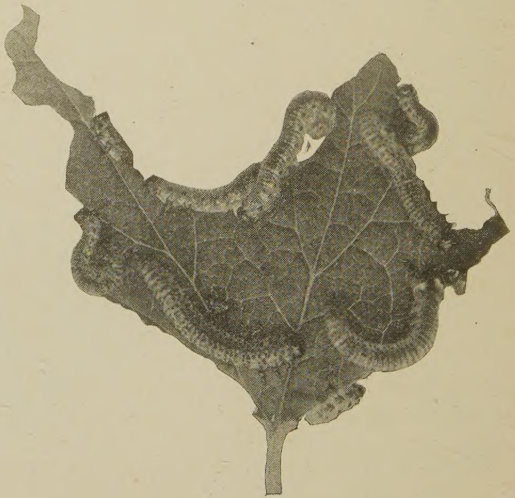


Fig. 156. *Currant-worms.*

Leaf-hopper. These small yellowish leaf-hoppers, erroneously called "thrips" suck the sap from the underside of the leaves causing them to turn brown and dry up. Spray the underside of the leaves very thoroughly with whale-oil soap, 1 lb. in 10 gals. of water, about July 1st, to kill the young leaf-hoppers. Repeat the application in a week or ten days. Cornell Bulletin 215.

Rose-chafer. The ungainly, long-legged, grayish beetles occur in sandy regions and often swarm into vineyards and destroy the blossoms and foliage. Spray thoroughly with arsenate of lead, 10 lbs. in 100 gals. of water. Repeat the application if necessary.

RASPBERRY, BLACKBERRY AND DEWBERRY.

Saw-fly. The greenish, spiny larvae feed on the tender leaves in spring. Spray with Paris green or arsenate of lead, or apply hellebore.

Cane-borer. The larva is a grub that burrows down through the canes causing them to die. In laying her eggs, the adult beetle girdles the tip of the cane with a ring of punctures causing it to wither and droop. In midsummer cut off and destroy the drooping tips.

CURRENT AND GOOSEBERRY.

Currant-worm. In the spring the small green, black-spotted larvae (Fig. 156) feed on the foliage, beginning their work on the lower leaves. A second brood occurs in early summer. When worms first appear, spray with 1 lb. Paris green or 4 lbs. arsenate of lead in 100 gals. of water. Ordinarily the poison should be combined with Bordeaux. See CURRENT LEAF-SPOT. After fruit is half grown use hellebore.



Fig. 157. *Rose aphid or plant-louse.*

ROSE.

Aphis and leaf-hopper. The green plant-lice (Fig. 157) usually work on the buds, and the yellow leaf-hoppers feed on the leaves. Spray, whenever necessary, with kerosene emulsion, diluted with 6 parts of water, or whale-oil or any good soap, 1 lb. in 5 or 6 gals. of water.

Rose-chafer. See under GRAPE.

Rose-slug. See under PEAR SLUG.

STRAWBERRY.

White grubs. These large curved white grubs (Fig. 158) are the larvae of the common June beetles.

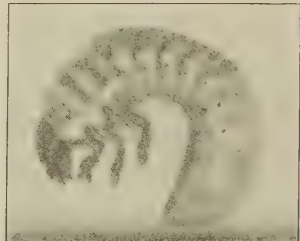


Fig. 158. *White grub.*

They live in the ground feeding on the roots of grasses, weeds, etc. Dig out grubs from beneath infested plants. Thorough early fall cultivation of land intended for planting will destroy many of the pupae.

POTATO.

Colorado potato-beetle.

The yellow striped beetle emerges from hibernation in the spring and lays masses of orange eggs on the underside of the leaves. The larvae are known as "slugs" and "soft-shells" (Fig. 145) and cause most of the injury to the vines. Spray with Paris green 2 lbs. in 100 gals. of water or arsenite of soda combined with Bordeaux mixture. It may sometimes be necessary to use a greater strength of the poison, particularly on the older "slugs."

Flea-beetles.

These small black beetles riddle the leaves with small holes and cause them to die. Bordeaux mixture as applied for potato blight protects the plants by making them distasteful to the beetles. See under POTATO BLIGHT.

CUCUMBER, MELON AND SQUASH.

Striped cucum- ber-beetle.

These yellow, black-striped beetles appear in numbers and attack the plants as soon as they are up. Plant early squashes as a trap-crop around the field. Protect the vines with screens until they begin to run, or keep them covered with Bordeaux mixture, thus making them distasteful to the beetles.

Squash-vine borer.

Squash vines are frequently killed by a white caterpillar, which burrows in the stem near the base of the plant. Plant a few early squashes between the rows of the late varieties as a trapcrop. As soon as the early crop is harvested, remove and burn the vines. When the vines are long enough, cover them at the joints with earth in order to develop secondary root systems for the plant in case the main stem is injured.

Aphis.

These dark green plant-lice feed on the undersides of the leaves causing them to curl and wither. Spray with kerosene emulsion diluted with 6 parts of water. It is necessary thoroughly to cover the underside of the leaves; the sprayer, therefore, must be fitted with an upturned nozzle. Burn the vines as soon as the crop is harvested and keep down all weeds.

Squash stink-bug.

The rusty-black adult emerges from hibernation in the spring and lays its eggs on the underside of the leaves. The nymphs suck the sap from the leaves and stalks causing serious injury. Trap the adults under boards in the spring. Examine the leaves for the smooth shining brownish eggs and destroy them. The young nymphs may be killed with kerosene emulsion.

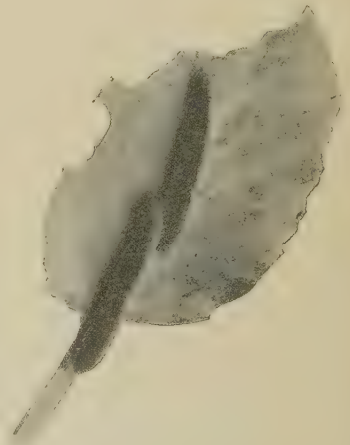


Fig. 159. *Imported cabbage-worms.*

CABBAGE AND CAULIFLOWER.

Cabbage-worm. The green caterpillars (Fig. 159) hatch from eggs laid by the common white butterfly. There are several broods every season.

If plants are not heading, spray with kerosene emulsion or with Paris green to which the sticker has been added. If heading, apply hellebore.

These small mealy plant-lice are especially troublesome during cool, dry seasons when their natural enemies are less active.

Cabbage aphid. Before the plants begin to head, spray with kerosene emulsion diluted with 6 parts of water, or whale-oil soap, 1 lb. in 6 gals. of water.

Cabbage root-maggot. The white maggots that feed on the roots (Fig. 160) hatch from eggs laid by a small fly somewhat resembling the common house fly, near the plant at the surface of the ground. Hollow out the earth slightly around every plant and freely apply carbolic acid emulsion diluted with 30 parts of water. Begin the treatment early, a day or two after the plants are up or the next day after they are set out. Repeat the applica-



Fig. 160. *Cabbage root-maggots.*

tion every 7 to 10 days until the latter part of May. It has also been found practicable to protect the plants by the use of tightly fitting cards cut from tarred paper. Cornell Bulletin 78.

ONION.

Onion thrips. Onion tops frequently turn white and die as the result of the feeding punctures caused by these minute yellowish insects. The injury is known as "white blast." Spray thoroughly with

kerosene emulsion diluted with 6 parts water, or whale-oil soap, 1 lb. in 4 gals. of water.

Onion maggot. For treatment see CABBAGE ROOT-MAGGOT.

GREENHOUSE INSECTS.

- White-fly.** The nymphs are small greenish, scale-like insects found on the underside of the leaves; the adults are minute, white, mealy winged flies. Spray with kerosene emulsion or whale-oil soap; or if infesting cucumbers or tomatoes, fumigate over night with hydrocyanic acid gas, using 1 oz. of potassium cyanide to each 1000 cubic feet of space.
- Green aphis.** Spray with kerosene emulsion when practicable, or fumigate with one of the tobacco preparations. If on violets, fumigate, using $\frac{1}{2}$ to $\frac{3}{4}$ oz. potassium cyanide for every 1000 cu. ft. of space and leave the gas in from $\frac{1}{2}$ to 1 hour.
- Black aphis.** This plant-louse is harder to kill than the green aphid, but may be controlled by the same methods.
- Red-spider.** Syringe off the plants with clear water two or three times a week, taking care not to drench the beds.
- Violet gall-fly.** Violets grown under glass are often greatly injured by a very small maggot, which causes the edges of the leaves to curl, turn yellowish and die. The adult is a very minute fly resembling a mosquito. Pick off and destroy infested leaves as soon as discovered. Fumigation is not advised for this insect or for red-spider.

III. INSECTICIDES.

M. V. SLINGERLAND AND C. R. CROSBY.

- Arsenate of lead.** This can be applied in a stronger mixture than other arsenical poisons without injuring the foliage. It is, therefore, much used against beetles and other insects that are hard to poison. It comes in the form of a paste and should be mixed thoroughly with a small amount of water before placing in the sprayer, else the nozzles will clog. Arsenate of lead and Bordeaux mixture can be combined without lessening the value of either. It is used in strengths varying from 4 to 10 lbs. per 100 gals., depending on the kind of insect to be killed.
- Paris green.** This is used in varying strengths, depending on the insect to be controlled and the kind of plant treated. Mix the Paris green into a paste and then add to the water. Keep the mixture thoroughly agitated while spraying. If for use on fruit trees, add 1 lb. of quick lime for every pound of Paris green to prevent burning the foliage. For potatoes it is frequently used alone, but it is much safer to use the lime. Paris green and Bordeaux mixture may be combined without lessening the value of either and the caustic action of the arsenic is prevented.
- Arsenite of soda.** (For use with Bordeaux mixture only). Sal soda 2 lbs.; water 1 gal.; arsenic 1 lb. Mix the white arsenic into a paste and then add the sal soda and water and boil until dissolved. Add water to replace any that has boiled away so that 1 gallon of stock solution is the result. Use 1 quart of this stock solution to 50 gallons of Bordeaux mixture for fruit trees. Make sure there is enough lime in the Bordeaux mixture to prevent the caustic action of the arsenic.

**Arsenite
of lime.**

(For use without Bordeaux mixture). Sal soda, 1 lb., water, 1 gal. white arsenic, 1 lb., quick lime, 2 lbs. Dissolve the white arsenic with the water and sal soda as above and use this solution while hot to slake the 2 lbs. of lime. Add enough water to make 2 gallons. Use 2 quarts of this stock solution in 50 gallons of water.

Hellebore.

For wet application, use fresh white hellebore, 1 oz., water, 2 or 3 gals., For dry application, use hellebore, 1 lb., flour or air-slaked lime, 5 lbs. This is a white, yellowish powder made from the roots of the white hellebore plant. It loses its strength after a time and should be used fresh. It is used as a substitute for the arsenical poisons on plants or fruits soon to be eaten.

**Kerosene
emulsion.**

Hard, soft or whale-oil soap, $\frac{1}{2}$ lb., water, 1 gal., kerosene, 2 gals. Dissolve the soap in hot water; remove from the fire while still hot and add the kerosene. Pump the liquid back into itself for five or ten minutes or until it becomes a creamy mass. If properly made the oil will not separate out on cooling.

For use on dormant trees, dilute with from 5 to 7 parts of water. For killing plant-lice on foliage dilute with from 10 to 15 parts of water. Crude oil emulsion is made in the same way by substituting crude oil in place of kerosene. The strength of oil emulsions are frequently indicated by the percentage of oil in the diluted liquid:

For a 10% emulsion add 17 gals. of water to 3 gals. stock emulsion.

For a 15% emulsion add 10 $\frac{1}{3}$ gals. of water to 3 gals. stock emulsion.

For a 20% emulsion add 7 gals. of water to 3 gals. stock emulsion.

For a 25% emulsion add 5 gals. of water to 3 gals. stock emulsion.

**Carbolic acid
emulsion.**

Soap, 1 lb.; water, 1 gal.; crude carbolic acid, 1 pint. Dissolve the soap in hot water, add the carbolic acid and agitate into an emulsion. For use against root-maggots, dilute with 30 parts of water.

Tobacco.

This is a valuable insecticide and is used in several forms. As a *dust* it is used extensively in greenhouses for plant-lice, and in nurseries and about apple trees for the woolly aphis. Tobacco *decoction* is made by steeping or soaking the stems in water. It is often used as a spray against plant-lice. Tobacco in the form of *extracts*, *punks* and *powders* is sold under various trade names for use in fumigating greenhouses.

Soaps.

An effective insecticide for plant-lice is *whale-oil soap*. Dissolve in hot water and dilute so as to obtain one pound of soap to every five or seven gallons of water. This strength is effective against plant-lice. It should be applied in stronger solutions, however, for scale insects. Home-made soaps and good laundry soaps, like ivory soap, are often as effective as whale-oil soap.

Miscible oils.

There are now on the market a number of preparations of petroleum and other oils intended primarily for use against the San José scale. They mix readily with cold water and are immediately ready for use. While quickly prepared, easily applied and generally effective, they cost considerably more than lime-sulfur wash. They are, however, less corrosive to the pumps and more agreeable to use. They are speci-

ally valuable to the man with only a few trees or shrubs who would not care to go to the trouble and expense to make up the lime-sulfur wash. They should be diluted with not more than 10 or 12 parts of water. Use only on dormant trees.

A good miscible oil can be made at home but it involves considerable labor and unless proper grades of the different materials are used there will be difficulty in combining them. Manufacturers of soaps and oils are now properly combining these materials and offering the resulting emulsifiers at reasonable prices that are considerably less than the cost of the proprietary miscible oils.

Quicklime, 20 lbs.
Lime and sulfur wash. Sulfur (flour or flowers) 15 lbs.
 Water, 50 gals.

The lime and sulfur must be thoroughly boiled. An iron kettle is often convenient for the work. Proceed as follows: Place the lime in the kettle. Add hot water gradually in sufficient quantity to produce the most rapid slaking of the lime. When the lime begins to slake, add the sulfur and stir together. If convenient keep the mixture covered with burlap to save the heat. After slaking has ceased, add more water and boil the mixture one hour. As the sulfur goes into solution, a rich orange red or dark green color will appear. After boiling sufficiently, add water to the required amount and strain into the spray tank. The wash is most effective when applied warm, but may be applied cold. If one has access to a steam boiler, boiling with steam is more convenient and satisfactory. Barrels may be used for holding the mixture, and the steam applied by running a pipe or rubber hose into the mixture. Proceed in the same manner as for boiling in the kettle until the lime is slaked, when the steam may be turned on. Continue boiling for 45 minutes to an hour, or more if necessary to get the sulfur well dissolved.

This mixture can be applied safely only when the trees are dormant,—late in the autumn after the leaves have fallen, or early in the spring before the buds swell. It is mainly an insecticide for San José scale, although it has considerable value as a fungicide for certain diseases, like the peach leaf-curl. As the San José scale is not killed unless the solution comes in contact with it, great care should be exercised to completely cover the branches.

Proprietary lime-sulfur washes are now on the market and are reported effective when used at the rate of 1 gallon of the wash to not more than 8 or 9 gallons of water.

Fumigation with hydrocyanic acid gas. Hydrocyanic acid gas is a deadly poison and the greatest care is required in its use. Always use 98 to 100% pure potassium cyanide and a good grade of commercial sulphuric acid. The chemicals are always combined in the following proportion: Potassium cyanide, 1 oz.; sulphuric acid, 2 fluid ozs.; water, 4 fluid ozs. Always use an earthen dish, *pour in the water first*, and add the sulfuric acid to it. Put the required amount of cyanide in a thin paper bag, and when all is ready, drop it into the liquid and leave the room immediately. For mills and dwellings, use 1 oz. of cyanide for every 100 cubic feet of space. Make the doors and windows as tight as possible by pasting strips of paper over the cracks. Remove the silver-ware and food, and if brass and nickel work cannot be removed cover with vaseline. Place the proper amount of the acid and water for every room in 2-gallon jars. Use two or more in large rooms or halls. Weigh out the potassium cyanide in paper bags and place them near the jars. When all is ready, drop the cyanide into the jars, beginning on the top floors, since the fumes are lighter than air.

In large buildings, it is frequently necessary to suspend the bags of cyanide over the jars by cords running through screw eyes and all leading to a place near the door. By cutting all the cords at once the cyanide will be lowered into the jars and the operator may escape without injury. Let the fumigation continue all night, locking all outside doors and placing danger signs on the house.

Fumigation of greenhouses. No general formula can be given for fumigating the different kinds of plants grown in greenhouses, as the species and varieties differ greatly in their ability to withstand the effects of the gas.

Ferns and roses are very susceptible to injury, and fumigation if attempted at all should be performed with great caution.

Fumigation will not kill insect eggs and thus must be repeated when the new brood appears. Fumigate only at night when there is no wind. Have the house as dry as possible and the temperature as near 60° as practicable.

IV. THE CONTROL OF PLANT DISEASES.

H. H. WHETZEL AND F. C. STEWART.

ALFALFA.

Dodder. This disease causes small areas of alfalfa to die. Around the

margins of these areas the ground is covered with a tangled mat of yellow threads that twine closely about the plants and kill them (Fig. 161). Infested spots should be closely mowed; the stubble sprinkled with kerosene, covered with dry hay and burned. Only seed free from dodder should be used. Samples of seed may be sent the Geneva Experiment Station to be examined for dodder. Alfalfa seed can be cleaned by sifting through 20x20 mesh sieve made of No. 34 wire. See Geneva Circular No. 8.

Leaf-spot. This is the most serious fungous disease of the crop in the

State. It causes the leaves to become spotted and yellow and to fall prematurely. New seeding when badly diseased, should be topped, *but never mowed closely*. When older fields are attacked, the hay should be cut a few days early to avoid loss of leaves and to permit a new growth that will usually outgrow the trouble. (Fig. 162.)



Fig. 161. Dodder on alfalfa, showing the slender cord-like stems and the bunches of small white flowers.

APPLE.

Scab.

Commonly known among growers as "the fungus." Usually most evident on the fruit. Spray with Bordeaux 5-5-50 or 3-3-50; first, just before the blossoms open; second, just

as the blossoms fall; third, 10 to 14 days after the blossoms fall. The second spraying seems to be the most important. Spray thoroughly. For the use of insect poisons with Bordeaux mixture, see CODLING-MOTH and BUD-MOTH. See also Cornell Bulletins 84 and 226. (Fig. 163.)

Fire-blight.

This is the same as Pear blight. It usually makes itself manifest on the apple

trees in three forms, *blossom blight*, *twig blight*, and *blight cankers* on limbs and body (Fig. 164). This disease is caused by bacteria which are distributed by bees and flies and is not controlled by spraying. Cutting out and destroying the diseased parts are the chief measures to be taken. Cut out blighted

twigs in young trees as fast as they appear. The bacteria of this disease are carried over winter in cankers on the main limbs and bodies of the trees. Remove all such cankers with sharp knife cutting well into the healthy bark and wash the wound with corrosive sublimate, 1 part to 1000 of water. Then paint the wound with heavy lead oil paint. See Cornell Bulletin, 236. Destroy or clean up all old pear and apple trees about the premises because such trees harbor the disease.

New York apple-tree canker.

This important fungous disease should not be confused with the "blight canker." Cankers are usually found on the main limbs of old trees, black and rough

(Fig. 165). Canker is very common on Twenty Ounce. Since the fungus enters through wounds, avoid breaking the bark. All wounds made in pruning should be promptly painted over. Cut out cankers and treat as for "blight cankers." Spray early in spring before the buds start with Bordeaux, 10-10-50, or soak the body and the limbs when making first application for scab. See Geneva Bulletins 163 and 185.

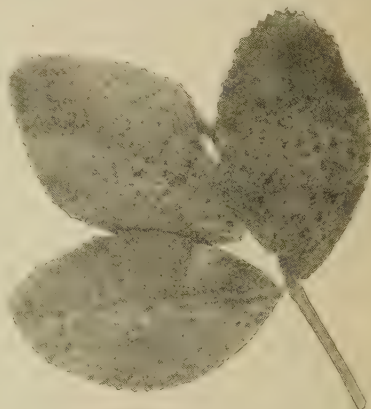


Fig. 162. *Alfalfa leaf-spot.*

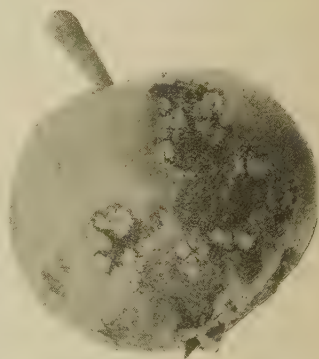


Fig. 163. *Apple-scab.*

ASPARAGUS.

Rust.

The most common and destructive disease of asparagus rust produces reddish or black pustules on the stems and branches.

Late in the fall, burn all affected plants. Fertilize liberally and cultivate thoroughly. During the cutting season, *permit no plants to mature* and

cut all wild asparagus plants in vicinity once a week. Rust may be partially controlled by spraying with Bordeaux, 5-5-50 containing a sticker of resin-sal soda soap (See page 362), but it is a difficult and expensive operation and probably not profitable except on large acreage. Begin spraying after cutting as soon as new shoots are 8 to 10 inches high and repeat once or twice a week until about September 15. See Geneva Bulletin 188. Dusting with sulfur has proved effective in California. See California Bulletins 165 and 172. Plant the varieties least affected by rust.

BEANS.

Anthracnose or pod-spot. A fungous disease commonly known among growers as "rust." It is carried over from one season to another in the seed. Plant clean seed obtained by selecting pods free from the diseased spots. Hand-sorting of seed, and seed treatment will not control this disease. When beans can be thoroughly hand-sprayed Bordeaux, 5-5-50, will control the trouble. Spray, first, just when the plants break through the ground; second, when first pair of leaves are expanded; third, when the pods have set. See Cornell Bulletin 239, also New Jersey Bulletin 151. (Fig. 166.)

Blight. A bacterial disease. Like the anthracnose, blight is carried over in the seed. It is difficult to control. It affects the leaves chiefly, forming large dead spots. Spraying with Bordeaux, as for anthracnose, is said to reduce the injury. See Cornell Bulletin 239 and New Jersey Bulletin 151.



Fig. 164. *Blight canker of apple.*

CABBAGE—CAULIFLOWER.

Black-rot. In this bacterial disease, bacteria get into the sap-tubes of the leaves clogging them and turning them black; the plants drop their leaves and fail to head. Practice crop rotation; soak seed 15 minutes in a solution made by dissolving one corrosive sublimate tablet in a pint of water. Tablets may be bought at drug stores. See Geneva Bulletins 232 and 251.

Club-root or club-foot. This is a slime mold disease. The parasite lives in the soil. Practice crop rotation. *Set only healthy plants.* Do not use manure containing cabbage refuse. If necessary to use infested land apply good stone lime, 2 to 5 tons per acre. Apply at least as early as the autumn before planting; two to four years is better. Lime the seedbed in same manner. See New Jersey Bulletin 98. This disease is sometimes confused with cabbage maggots, which see. (Fig. 167.)

CARNATION.

**Rhizoctonia,
stem-rot.**

The cause of this disease is a soil fungus. The plants wilt suddenly. The stem is affected with soft rot at or below the surface of the soil. In the field, change location of the plants frequently; annually, if possible. In the benches, used sterilized soil or at least use fresh soil. After transplanting into the greenhouse, keep the temperature as low as possible until the plants become established. Stir the soil frequently. Avoid over-watering. See Geneva Bulletin 186.

**Fusarium,
stem-rot.**

This is a dry rot. Plants affected by this disease die slowly, usually a branch at a time. The treatment same as for Rhizoctonia stem-rot.

Rust.

This disease can be recognized by the brown, powdery pustules on the stem and leaves. Plant only the varieties least affected by it. Take cuttings only from healthy plants. Spray (in the field, once a week; in the greenhouse, once in two weeks) with copper sulfate, 1 lb. to 20 gals. of water. Keep the greenhouse air as dry and cool as is compatible with good growth. Keep the foliage free from moisture. Train the plants so as to secure a free circulation of air among them. See Geneva Bulletin 100.

Leaf-spot.

Round, grayish spots on the stem and leaves are evidences of this disease. Treatment is the same as for rust.

CELERY.

**Cerospora,
leaf-blight.**

This is sometimes known as "early blight." It often appears in the seed-bed and becomes destructive early in the summer. It is favored by hot weather, either wet or dry. Spray with ammoniacal copper carbonate, 6-3-45, making about five or eight applications beginning while the plants are still in the seed-bed. Bordeaux, 5-5-50, may be used for the earlier application. Spray often enough to keep new growths of leaves covered; destroy diseased plants and refuse. See Cornell Bulletin 132.

**Septoria, leaf-
blight or
"late blight."**

Leaf blight is a fungous disease appearing late in the season. It is often destructive after celery is stored. The same treatment as for "early blight" is used except that spraying should be continued up to the time the plants are harvested. See Cornell Bulletin 132. Well-drained celery fields, half-shaded do not seem to suffer from either blight.



Fig. 165. New York apple-tree canker.

CHERRY.

Black-knot. A fungus, the spores of which are carried from tree to tree by the wind and thus spread the infection is the cause of this disease. The same fungus also affects plums. Cut out and burn all knots as soon as discovered. See that the knots are removed from all plums and cherry trees in the neighborhood. See Cornell Bulletin 81.

**Brown-rot
of fruit.**

Produced by the same fungus that causes the brown rot of plums and peaches. See Cornell Bulletin 98, pp. 409-410. See also Geneva Bulletin 98. See page 362.

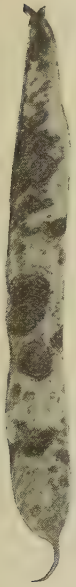


Fig. 166.
*Bean an-
thrachnose.*

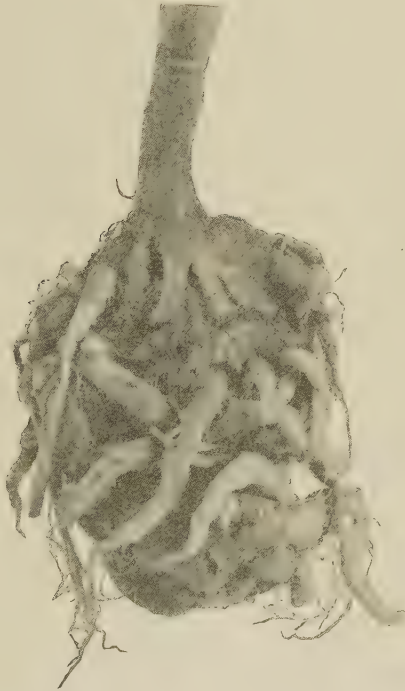


Fig. 167. *Club-root of cabbage.*

Leaf spot.

This is a fungous disease in which the leaves become thickly covered with reddish or brown spots and fall prematurely; badly affected trees winterkill. Often, the dead spots drop out leaving clear-cut holes. Spray with Bordeaux, 5-5-50. Make four applications; first, just before blossoms open; second, when fruit is free from calyx; third, two weeks later; fourth, two weeks after third. See Michigan Board Agriculture Report 1906, p. 103.

**Powdery
mildew.**

It attacks leaves at the tip of the growing shoots and is often serious on nursery stock. The leaves curl and show white mealy growth of the fungus. Dust heavily with sulfur or spray with potassium sulfide, 1 oz. to 3 gals. water.

CHRYSANthemum.

- Septoria, leaf-spot.** This is also a fungous disease. Spray with Bordeaux, 5-5-50, every ten days or often enough to protect new foliage. Ammoniacal copper carbonate may be used but it is not so effective. See Geneva Annual Report 1892, p. 558.
- Rust.** Treat as for leaf-spot. Avoid wetting foliage when watering.

CUCUMBER.

Wilt. This is a disease caused by bacteria that get into the sap-tubes of the leaf and stem, clogs and destroys them, causing the plant to wilt. The bacteria are distributed chiefly by striped cucumber beetles. Destroy the beetles or drive them away by thorough spraying with Bordeaux, 5-5-50. Gather and destroy all wilted leaves and plants. The most that can be expected is that the loss may be slightly reduced.

Downy mildew. This most serious fungous disease of the cucumber is known among growers as "the blight." The leaves become mottled with yellow, show dead spots and then dry up. Spray with Bordeaux, 5-5-50. Commence spraying when the plants begin to run and repeat every 10 to 14 days throughout the season. See Geneva Bulletins 119 and 156.

CURRANT.

Leaf-spots and anthracnose. This is caused by two or three different fungi. The leaves become spotted, turn yellow and fall prematurely. It may be controlled by three to five sprayings with Bordeaux, 5-5-50, but it is doubtful whether the disease is sufficiently destructive on the average to warrant so much expense. *Upon the first appearance of currant worms spray with Bordeaux and Paris green (1 lb. to 100 gals. or arsenate of lead, 4 lbs. to 100 gals).* Repeat if a second brood of worms appears. See Iowa Bulletin 30 and Geneva Bulletin 199. (Fig. 168.)

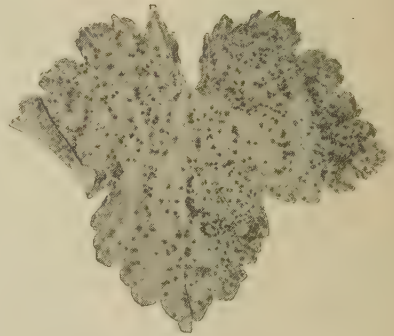


Fig. 168. *Currant leaf-spot.*

Cane-blight or wilt Very destructive in the Hudson Valley. Canes die suddenly while loaded with fruit and leaves like those attacked by the cane borer. Caused by a fungus which kills the bark, in places and discolors the wood. No definite line of treatment has been established, but the following is suggested. Beginning when the plants are small go over the plantation three or more times every summer and cut out and burn all canes showing signs of disease. See Geneva Bulletin 167, p. 292.

GINSENG.

- Alternaria blight.** This is the most destructive and common disease of cultivated ginseng. First, spray the surface of the soil thoroughly with copper sulfate solution, 1 lb. to 10 gallons, early in the spring before the plants come through; second, spray with Bordeaux, 5-5-50, as soon as the plants begin to break through the soil. Add sticker (see page 32). Spray repeatedly while the plants are coming through the soil, making a special effort to spray the stems as it is on these that the disease first becomes established in the spring. Spray to keep plant thoroughly covered throughout the season. Spray seed heads thoroughly just after the blossoms fall and again when the berries are two-thirds grown, to prevent "blast" caused by the *Alternaria* fungus. Destroy diseased tops. See *Special Crops*, Feb. 1907, Vol. 6, No. 54, p. 22.
- Wilt.** A disease caused by a fungus in the sap-tubes of the root. Wilt is checked by removing the wilted plants as soon as discovered. See *Cornell Bulletin* 219.
- Root-rots.** These are caused by different soil fungi. Favored by wet soggy soils. Drain the soil thoroughly.

GOOSEBERRY.

- Powdery mildew.** The fruit and leaves are covered with a dirty white growth of fungus. In setting a new plantation, choose a site where the land is well underdrained and where there is a good circulation of air. Cut away drooping branches. Keep the ground underneath free from weeds. Spray with potassium sulphide, 1 oz. to 2 gals; commence when the buds are breaking and repeat every 7 to 10 days until the fruit is gathered. Powdery mildew is very destructive to the European varieties. See *Geneva Bulletins* 133 and 161.

GRAPE.

- Black-rot.** This is the most destructive fungus disease of grapes in this state. It is carried over from one season to the next chiefly in old rotted berries or "mummies" that fall to the ground or cling to the vines. Remove all mummies that cling to the arms at trimming time. Plow early, turning under all old mummies and diseased leaves. Rake all refuse under the vine into the last furrow and cover with the grape hoe. This cannot be too thoroughly done. The disease is favored by wet weather and weeds or grass in the vineyard. Use surface cultivation and keep down all weeds and grass. Keep the vines well sprouted; if necessary sprout twice. Spray with Bordeaux mixture, 5-5-50, until the middle of July, after that with ammoniacal copper carbonate. The number of sprayings will vary with the season. Make the first application when the third leaf shows. Infections take place with each rain, and occur throughout the growing season. The foliage should be protected by a coating of the spray *before* every rain. The new growth, especially, should be well sprayed. When the foliage becomes dense the clusters should be sprayed with a "trailer" or hand-spraying device, about four applications of Bordeaux mixture and two of the ammoniacal copper carbonate will be necessary. Apply 80 to 100 gallons of spray to the acre. Use 100 to 140 lbs. pressure; use a 1-16 inch hole in the disk of the

nozzle. See Cornell Bulletin 254. For use of insecticides in Bordeaux, see "STEELY-BEETLE."

Downy mildew.

This is a fungous disease most evident on the leaves making large brown spots on upper surface with white downy growth beneath. It also attacks the green fruit, causing what is known to growers as "hard white berry." Bordeaux as applied for BLACK ROT will control this disease.

LETTUCE.

Drop or rot.

This is a fungous disease often destructive in greenhouses, discovered by the sudden wilting of the plants. It is completely controlled by steam sterilization of the soil to the depth of two inches or more. If it is not feasible to sterilize the soil, use fresh soil for every crop of lettuce. See Massachusetts Bulletin 69.

MUSKMELON.

Downy mildew.

This is commonly called "blight" and is a very troublesome disease. The leaves show angular, dead brown spots then dry up and die; the fruit often fails to ripen and lacks flavor. It is caused by the same fungus as is the downy mildew of cucumbers; no effective method of control is known. While Bordeaux has proven effective in controlling the downy mildew on cucumbers it seems to be of little value in fighting the same disease on melons. See Report of Botanist Connecticut Station, 1904.

Wilt.

This is same as the wilt of cucumbers; same treatment is given.

OATS.

Smut.

The most common and destructive disease of oats is smut, carried over from one season to the next by fungus spores on the seed. Entirely prevented by treating the seed oats before planting with a solution of formalin, 1 pint to 45 or 50 gallons of water. Place the oats on a clean floor and sprinkle on the formalin as they are shoveled over. Use one gallon to the bushel. Mix the oats thoroughly, then shovel them into a pile and cover with blankets or canvas. After standing in the pile from two to four hours the oats, if they are to be drilled should be spread out to dry; or they may be sown by hand without drying. Use one peck more seed per acre to allow for swelling of the grain. Treatment once in three years is usually sufficient to prevent material loss from smut. See U. S. Farmers Bulletin 250 and Wisconsin Bulletin 111.

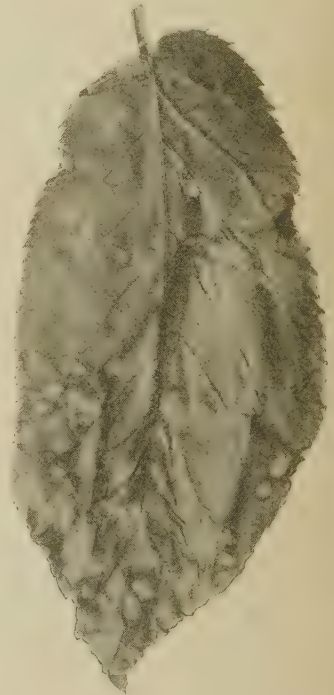


Fig. 169. *Ginseng blight.*

ONION.

Mildew.

or blight as it is commonly called is a fungous disease, much like the blight of potatoes. Spray with Bordeaux, 5-5-50, beginning when the plants show three leaves. Repeat every ten days until crop is harvested. Add one gallon sticker (see page 362) to every 50 gallons of the mixture. It is useless to begin spraying after the disease appears. See Cornell Bulletin 218.

Smut.

This can be detected by the black pustules on the leaves and bulbs. It is troublesome only where onions are grown extensively; it may attack the seedlings killing them outright, or may appear on mature bulbs in fall. Onions from sets or those started in clean soil and transplanted seldom suffer. Practice crop rotation. Drill into the rows when planting seed, 100 lbs. sulfur and 50 lbs. air-slaked lime mixed, to the acre. See Geneva Bulletin 182.

PEACH.

Brown-rot

is the most serious fungous disease of stone fruits in this state and one of the most difficult to control. Plant resistant varieties.

Prune the trees so as to let in sunlight and air. Thin the fruit well. As often as possible pick and destroy all rotten fruits. In the fall destroy all fruits remaining on the trees and on the ground. Spray with Bordeaux mixture before the buds break. Owing to danger of injuring the foliage later applications of copper compounds are not recommended. The self-boiled lime-sulfur wash (see page 362) is now being advocated for the control of this and other diseases of peach. In some experiments carried on by the U. S. Dept. Agr. 1907 the loss from this disease was reduced from 73% on unsprayed trees to about 10% on sprayed rows. The new remedy is at least worth a trial. Spray with self-boiled lime-sulfur wash, 10-15-50. First application when fruit is about the size of the end of your thumb. Repeat every two weeks until about two weeks before fruit ripens. See American Pomological Society Report 1907, also Report Missouri Horticultural Society, 1907. (Fig. 170.)

Leaf-curl

is a fungous disease in which the leaves become swollen and distorted in spring and drop during June and July. Elberta is an especially susceptible variety. Easily and completely controlled by spraying the trees once, *before the buds swell* with Bordeaux, 5-5-50, or with the lime-sulfur mixtures used for San José scale (see under fungicide). See Cornell Bulletins 164 and 180, Michigan Special Bulletins 27 and 30. Copper sulfate 2 lbs.



Fig. 170 *Mummies on peach tree, the result of brown-rot.*

to 50 gals. water is also effective. The addition of lime, however, makes it easy to tell where the spray has been applied.

Black-spot or scab.

This often proves troublesome in wet seasons and particularly in damp or sheltered situations. While this disease attacks the twigs and leaves it is most conspicuous and injurious on the fruit where it appears as dark spots or blotches. In severe attacks, the fruit cracks. In the treatment of this disease, it is of prime importance to *secure a free circulation of air* about the fruit. Accomplish this by avoiding low sites, by pruning and by removal of windbreaks. Spray as for leaf-curl and follow with two applications of potassium sulfide, 1 oz. to 3 gals. the first being made soon after the fruit is set and the second when the fruit is half grown. The self-cooked lime-sulfur wash has been shown to be very effective against this disease. See BROWN ROT. (Fig. 171.)

Yellows

is a so-called "physiological disease." Cause unknown. Contagious and quite serious in some localities. Known by the premature ripening of the fruit, by red streaks and spots in the fruit flesh and by the peculiar clusters of sickly, yellowish shoots that appear on the limbs here and there. Eradication is the only means of control. Dig out and burn diseased trees as soon as discovered.

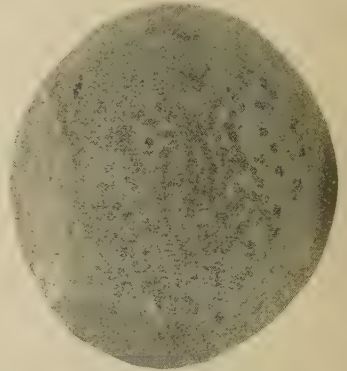


Fig. 171. *Black-spot on peach.*

PEAR.

Fire-blight.

This is the same as fire blight of apple but it is more destructive to pears. It kills the twigs and branches on which the leaves suddenly blacken and die but do not fall. It also produces cankers on the trunk and large limbs. Prune out blighted branches as soon as discovered, cutting 6 to 8 inches below the lowest evidences of the disease. Clean out limb and body cankers as described for fire blight on apple trees. Disinfect all large wounds with corrosive sublimate solution, 1 to 1000, and cover with coat of paint. See Cornell Bulletin 236. *Avoid forcing a rapid, succulent growth of wood.* Plant the varieties least affected.

Scab

is a fungous disease very similar to apple scab but it is not the same, however. It is very destructive to some varieties, as for example, Flemish Beauty and Seckel. Spray three times with Bordeaux as for apple scab. See Cornell Bulletin 145 and Geneva Bulletins 67 and '84. (Fig. 172.)



Fig. 172. *Pear-scab.*

PLUM.

Brown-rot

is the same as brown rot of peach, and should be treated in the same way. (Fig. 173.)

Leaf-spot.

This is the same as leaf-spot of cherry and may be controlled by two or three applications of Bordeaux, 5-5-50. Make the first one about ten days after the blossoms fall and the others at intervals of about three weeks. This applies to European varieties. Japan plums should not be sprayed with Bordeaux. See Geneva Bulletins 98 and 117.

Black-knot

is the same disease as black knot of cherries and is controlled in the same way. For control of this disease by spraying see Cornell Bulletin 81.



Fig. 173. *Brown-rot on plum.*

POTATO.

There are different kinds of potato blight and rot. The most important are early blight and late blight—both fungous diseases.

Early blight affects only the foliage. Late blight kills the foliage and often rots the tubers. Two serious troubles often mistaken for blight are: (1) Tip burn, the browning of the tips and margins of the leaves due to dry weather; and (2) flea-beetle injury, in which the leaves show numerous small holes and then dry up. The loss from blight and flea-beetles is enormous—often, one-fourth to one-half the crop. For blight, rot and flea-beetles spray with Bordeaux, 5-5-50. For addition of insect poisons see POTATO FLEA-BEETLES. Commence when the plants are 6 to 8 inches high and repeat every 10 to 14 days during the season, making 5 to 7 applications in all. Use from 40 to 100 gallons per acre at each application. Under conditions exceptionally favorable to blight it will pay to spray as often as once a week. See Geneva Bulletins 101, 123, 221, 241, 264, 267, 279 and 290.

Scab

is caused by a fungus that attacks the surface of the tubers. It is carried over on diseased tubers and in the soil. In general, when land becomes badly infested with scab it is best to plant it with other crops for several years. See Vermont Bulletin 85 and Maine Bulletin 141.

QUINCE.

Leaf and Fruit Spot.

This is a fungous disease producing round, reddish-brown spots on the leaves and fruit. Spray three times with Bordeaux as for apple and pear scab. See Cornell Bulletin 145. (Fig. 174.)



Fig. 174. *Fruit-spot on quince.*

RASPBERRY.

Anthracnose is very destructive to black raspberries but not often injurious to the red varieties. It is detected by the circular or elliptical, gray, scab-like spots on the canes. Avoid taking young plants from diseased plantations. Remove all old canes and badly diseased new ones as soon as the fruit is gathered. Although spraying with Bordeaux, 5-5-50, will control the malady, it may not be profitable. If spraying seems advisable make the first application when the new canes are 6 to 8 inches high and follow with two more at intervals of 10 to 14 days. See Geneva Bulletin 124. (Fig. 175.)

Cane-blight or wilt. This is a destructive disease affecting both red and black varieties. Fruiting canes suddenly wilt and die. It is caused by a fungus which attacks the cane at some point and kills the bark and wood thereby causing the parts above to die. No successful method of treatment is known. In making new settings use only plants from healthy plantations. Remove the fruiting canes as soon as the fruit is gathered. See Geneva Bulletin 226.

Red-rust is often serious on black varieties but does not affect red ones. It is the same as red rust of blackberry. Dig up and destroy affected plants. This is often destructive, particularly to the red varieties. It is detected by the large, irregular knots on the roots and at the crown underground. It is a contagious disease. *Never set plants showing root-knots.* Avoid planting on infested land. The same disease occurs on peaches.

ROSE.
Black leaf spot is one of the commonest diseases of the rose. It causes the leaves to fall prematurely. Spray with Bordeaux, 5-5-50, beginning as soon as the first spots appear on the leaves. Two or three applications at intervals of ten days will very largely control the disease. Ammoniacal copper carbonate may be used on roses grown under glass. Apply once a week until disease is under control.

Mildew. For greenhouse roses, keep the steam pipes painted with a paste made of equal parts lime and sulfur mixed up with water. The mildew is a surface-feeding fungus and is killed by the fumes of the sulfur. Out-door roses that become infested with the mildew may be dusted with sulfur or sprayed with a solution of potassium sulfide, 1 oz. to 3 gallons water. Spray or dust with the sulfur two or three times at intervals of a week or ten days.

STRAWBERRY.

Leaf-spot is the most common and serious fungous disease of the strawberry. It is also called rust and leaf-blight. The leaves show spots which are, at first, of a deep purple color, but later enlarge



Fig. 175. Raspberry anthracnose.

and the center becomes gray or nearly white. The fungus passes the winter in the old, diseased leaves that fall to the ground. In setting new plantations, remove all diseased leaves from the plants before they are taken to the field. Soon after growth begins, spray the newly set plants with Bordeaux, 5-5-50. Make three or four additional sprayings during the season. The following spring, spray just before blossoming and again 10 to 14 days later. If the bed is to be fruited a second time, mow the plants and burn over the beds as soon as the fruit is gathered. Plant resistant varieties. See Cornell Bulletin 79.

TOMATO.

Septoria, leaf-spot

is the most destructive foliage disease of the tomato in the state. The distinguishing character of this fungous disease is that it begins on the lower leaves and works towards the top, killing the foliage as it goes. It is controlled with difficulty because it is carried over winter in the diseased leaves and tops that fall to the ground. When setting out plants, pinch off all the lower leaves that touch the ground; also any leaves that show suspicious looking dead-spots. The trouble often starts in the seed-bed. Spray plants very thoroughly with Bordeaux, 5-5-50, beginning as soon as the plants are set out. Stake and tie up for greater convenience in spraying. Spray under side of the leaves. Spray every week or ten days.

TURNIP.

Club root

is the same disease as the club root of cabbage. Same treatment.

Soft rot

is a bacterial disease, the same as soft rot of cabbage. Plant on soils free from the disease. Avoid planting varieties especially susceptible to the trouble. The white turnip seems to be more susceptible than the yellow varieties.

WHEAT.

Stinking smut.

This is usually not detected until harvest time. The affected heads appear nearly normal, only the kernels being attacked. The diseased kernels are composed of a brown, foul-smelling powder. They may be crushed easily between the thumb and finger. Readily controlled by treating the seeds with formalin solution as for oat-smut, which see. See U. S. Farmers' Bulletin 250.

Loose smut

is conspicuous in the field at "heading" time. Both grain and chaff are attacked and transformed into a loose black powder most of which is blown away by harvest time leaving the stalk bare. It is common and destructive. In 1907, the average loss in New York was at least 10 per cent. This smut is not controlled by treatment with formalin or other chemicals, but should be prevented by treating the seeds with hot water as follows: Soak sack of wheat in cold water for 12 hours, drain 1 hour; submerge sack for ten minutes in water held at temperature of 130° F. The temperature must not rise above this as it would then injure the germinating ability of the grain.

V. FUNGICIDES.

H. H. WHETZEL AND C. S. WILSON.

The most important fungicides are as follows: Bordeaux mixture, ammoniacal copper carbonate, potassium sulfide, copper sulfate, flowers of sulfur, corrosive sublimate, formalin, lime-and-sulfur wash.

Bordeaux mixture. Copper sulfate, 5 lbs.
Stone lime or quicklime (unslaked), 5 lbs.
Water, 50 gals.

Bordeaux is the most important fungicide for general use. The strength varies according to the plant to be sprayed. The formula given above is the strength usually recommended. When a different strength is necessary, the formula is given under that disease. Stock mixtures of copper sulfate and lime are desirable. They are prepared in the following manner:

Copper sulfate

Dissolve the required amount of copper sulfate in water in the proportion of one pound to one gallon several hours before the solution is needed, suspend the copper sulfate crystals in a sack near the top of the water. A solution of copper sulfate is heavier than water. As soon, then, as the crystals begin to dissolve the solution will sink, bringing water again in contact with the crystals. In this way, the crystals will dissolve much sooner than if placed in the bottom of the barrel of water. In case large quantities of stock solution are needed, two pounds of copper sulfate may be dissolved in one gallon of water.

Lime.

Slake the required amount of lime in a tub or trough. Add the water slowly at first, so that the lime crumbles into a fine powder. If small quantities of lime are used, hot water is preferred. When completely slaked, or entirely powdered add more water. When the lime has slaked sufficiently, add water to bring it to a thick milk, or to a certain number of gallons. The amount required for each tank of spray mixture can be secured approximately from this stock mixture which should not be allowed to dry out.

To make Bordeaux.

Take 5 gallons of stock solution of copper sulfate for every fifty gallons of Bordeaux required. Pour this into the tank. Add water until the tank is about two-thirds full. From the stock lime mixture take the required amount. Knowing the number of pounds of lime in the stock mixture and the volume of that mixture, one can take out approximately the number of pounds required. Dilute this a little by adding water, and strain into the tank. Stir the mixture, and add water to make the required amount. Experiment stations often recommend the diluting of both the copper sulfate solution and the lime mixture to one half the required amount before pouring together. This is not necessary, and is often impracticable for commercial work. It is preferable to dilute the copper sulfate solution. Never pour together the strong stock mixtures and dilute afterward. Bordeaux mixture of other strengths as recommended is made in the same way, except that the amounts of copper sulfate and lime are varied according to the requirements.

The ferro-cyanide test.

It is not necessary to weigh the lime in making Bordeaux mixture for a simple test can be used to determine when enough of a stock lime mixture has been added. Dissolve an ounce of yellow prussiate of potash in a pint of water and label it "poison."

Cut a V-shaped slit in one side of the cork so that the liquid may be poured out in drops. Add the lime mixture to the diluted copper sulfate solution until the ferro-cyanide test solution *will not turn brown* when dropped from the bottle into the mixture. It is always best to add a considerable excess of lime.

BORDEAUX INJURY. (Fig. 176.)

Some plants are injured by the ordinary strength of Bordeaux even when properly made. Others, like the apple, are sometimes injured by quite a weak Bordeaux under certain weather conditions. The leaves of most varieties of stone fruits, especially, peaches, and Japanese plums are almost sure to be injured by Bordeaux except in very weak mixtures. The injury to these plants consists usually of small holes in the leaves, very similar in appearance to the shot-hole effect of certain fungi. The injury on apple occurs on both the leaves and the fruit. On the leaves it consists of quite definite brown spots very much like certain leaf spots due to fungi. The injury on the fruit takes the form of russetting. It may even cause large cracks to appear. Some varieties of apples suffer more than others. Wet weather during spraying season appears to be one of the chief factors in the production of Bordeaux injury on apples. It has also been shown that "the more copper sulfate, the greater the injury." It is to be understood, however, that injury from Bordeaux is much less common and serious than injury from the fungous disease, to prevent which it is applied. For a fuller discussion of this subject see Geneva Bulletin 287.

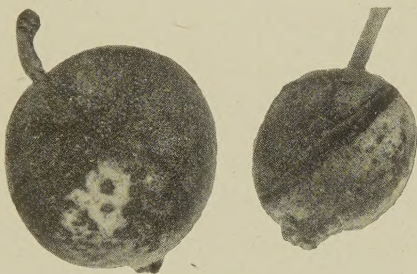


Fig. 176. *Bordeaux injury on apples.*

Ammoniacal copper carbonate. Copper carbonate, 5 oz.; ammonia, 3 pts.; water, 50 gals. Dilute the ammonia in seven or eight quarts of water. Make a paste of the copper carbonate with a little water. Add the paste to the diluted ammonia, and stir until dissolved. Add enough water to make fifty gallons. This mixture loses strength on standing, and therefore should be made as required. It is used in place of Bordeaux where one wishes to avoid the coloring of maturing fruits or ornamental plants. Probably, it is not as effective as Bordeaux.

If large amounts of the above mixture are required, it is more economical for the grower himself to make the copper carbonate. Proceed as follows: Dissolve 12 lbs. of copper sulfate (blue vitriol) in 12 gals. of water in a barrel. Dissolve 15 lbs. of sal soda in 15 gals. of water (preferably hot). Allow the solution to cool; then add the sal soda solution to the copper sulfate solution, pouring slowly in order to prevent the mixture from boiling up and running over. A fine precipitate which will settle to the bottom after the mixture has stood about twelve hours is formed. Siphon off the clear liquid above. Wash the precipitate by adding clear water, stirring and again allowing to settle. Siphon off the clear water, strain the precipitate through muslin, and allow it to dry. This is copper carbonate. The above amounts will make about six pounds.

Potassium sulfide.

Potassium sulfide (liver of sulfur), 3 oz.; water, 10 gals. As this mixture loses strength on standing, it should be made just before using. It is particularly valuable for the powdery mildew of many plants, especially gooseberry, carnation rust, rose mildew, etc.

Copper sulfate.

Copper sulfate, 1 lb.; water, 15-25 gals. Dissolve the copper sulfate in the water. It is then ready for use. One pound in twenty gallons of water has been found effective against peach leaf-curl. This mixture should never be applied to the foliage,

but must be used before the buds break. A much weaker solution has been recommended for trees in leaf, but it is rarely used.

Sulfur.

Sulfur has been found to possess considerable value as a fungicide. The flower of sulfur may be sprinkled over the plants, especially when they are wet. It is most effective in hot dry

weather. In rose houses, it is mixed with half its bulk of lime, and made into a paste with water. This is painted on the steam pipes. The fumes destroy mildew on the roses. Mixed with lime, it has proved effective in the control of onion smut when drilled into the rows with the seed. Sulfur is not effective against black rot of grapes, and many other diseases.

Corrosive sublimate solution.

Corrosive sublimate, 1 oz.; water, 7 gals. An effective solution for potato scab. Soak seed potatoes one and one-half hours. It is also a good antiseptic for dressing wounds. After cutting out fire blight or canker, swab the wound thoroughly with this solution.

Formalin.

This is a gas dissolved in water. Commercially, it has a strength of about forty per cent. One pint dissolved in thirty gallons of

water is used effectively in preventing potato scab (soak tubers for half an hour, and plant in clean soil), or smut of oats and stinking smut of wheat (soak seed in solution for ten minutes, drain and sow the next day).

The lime-and-sulfur wash has considerable value as a fungicide.

Lime and sulfur wash.

For its preparation and use, see under INSECTICIDES.

A modified form of this wash, known as the "self-cooked" lime-sulfur wash, is now being recommended for the spraying of peaches, plums and apple foliage. It is said to cause no injury

to the leaves or fruit. Good results have been secured in controlling brown rot and scab of peaches. Prepare as follows: Place ten pounds of sulfur and fifteen pounds of stone-lime in a barrel. Add hot water slowly to slake the lime, keeping the mass wet, but not submerged. Stir occasionally. Part of the large lumps of lime may be kept out at first and added after slaking has progressed to some extent, thus prolonging the slaking and heating. When slaked, dilute to fifty gallons, and apply as you would Bordeaux.

"Sticker" or adhesive.

Resin, 2 lbs.; sal soda, (crystals) 1 lb.; water, 1 gal. Boil until of a clear brown color—one to one and one-half hours. Cook in iron kettle in the open. Useful for onions, cabbage and other plants hard to wet. Add this amount to each fifty gallons of

Bordeaux. For other plants, add this amount to every one hundred gallons of the mixture. This mixture will prevent the Bordeaux from being washed off by the heaviest rains.